

# CHAPTER 11

## Conclusions

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The objective of this study was to demonstrate how ecological habitat suitability functions can be derived and linked to the hydrologic variables that are being managed. We desired a simple, transparent way to link ecology to hydrology, a way that would make it easy for anyone to understand, modify, test, and evaluate this linkage. Hydrologic targets and performance measures are commonly used to characterize the goals of the Everglades restoration effort. They are based on the assumption that if the hydrology can be managed so as to mimic what it was like prior to extensive management and drainage over the last century, the ecosystems may eventually return to natural, predrainage system conditions. It may or it may not return to this condition, but in any case it will be expensive. Along the way towards restoration it may turn out to be financially infeasible to continue – at least to the desired end. So, the questions are, “What if we do not get the water just right? What if we can get it only 90 percent right? What difference will it make? Is the added environmental benefit worth the added cost, assuming it is physically and politically possible? Where or how should limited financial resources be spent to get the greatest ecological benefit?” Questions like these require some link between hydrology and ecology.

The habitat suitability index models described in this document, although simplistic, provide trends and relative degrees of ecological response that allow comparisons of predrainage, current, and restored hydrologic conditions, at least with respect to the indicator features that were modeled. Different ecosystem indicators respond to these management-dependent hydrologic variables in different ways at different times and in different places or subregions of the Everglades. In this study, we chose six example indicators, some varying only over space, some only over time, and some over both space and time. The trophic levels included periphyton (algae), fish, alligators, and wading birds. Landscape features were the unique ridge and slough and tree island topographies that seems to be dependent on flow as well as depth variables, in spite of extremely low velocities through vegetation over a slope gradient that averages about 2 inches per mile.

The habitat suitability models presented in this document provide decision makers and planners with some additional insights about how the selected landscape features and faunal groupings have changed with the drainage and compartmentalization of the Everglades, and how and to what degree the restoration of more natural hydrologic

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conditions may translate to the restoration of desired ecological trends. Individual habitat suitability indices and the relationships among the groups of habitat suitability index models are of course based on the particular functions that were defined and how they were combined with hydrologic simulation output.

Where possible, the habitat suitability indices defined in this document were verified against field observation or best professional judgment. When applied to predrainage, current, and restored hydrologic simulations, habitat suitability index results showed, in some cases, room for improvement. Comparison among different habitat suitability indices helped quantify the relationship between different habitats interwoven within the Everglades mosaic. Anomalies in the balance between different habitat suitability indices indicated areas where further investigation of both the suitability index and our understanding of the inter-relationship between habitats and species, as well as our conceptualization of these relationships are needed. Sensitivity analyses showed the need for further refinement of the definition of some of the indices and also possible refinement of hydrologic model estimates of the predrainage conditions.

We lacked water quality modeling results, hence, our habitat suitability indices were functions of only water quantity variables. This assumes that there is a deterministic relationship between quality and quantity, and that this relationship is known. Neither is true, but until water quality models become operational, this together with perhaps some sensitivity analysis regarding the assumed qualities, is the best we can do.

Assumptions in the habitat suitability indices are expected to change over time as new knowledge becomes available and new habitat suitability index functions will likely be added for other indicator species. Hence, results and conclusions presented in this document, although accurate for the specified functions, are more intended to illustrate how such information can be derived and used in the absence of more detailed ecosystem modeling. While ecosystem habitat, quantified using habitat suitability indices, is not necessarily a measure of ecosystem response or condition, it is a reasonable approximation. Future challenges include not only defining habitat suitability functions that better represent those links between the water being managed and the relative ecosystem habitat response, but also learning how to best combine, over time and/or over space, various habitat indicators for different ecological indicator species or landscape types.

Obtaining an overall ecosystem habitat index could be considered mainly a scientific issue that requires the participation and best judgments of many different ecologists. If scientific consensus is not reached, then these relative measures of ecosystem condition will likely be less influential in the continuing political debate over how to manage South Florida's water for not only the Everglades ecosystem but also for water supply, flood control, and recreation.

Managing water so as to satisfy, to the greatest extent possible given the financial resources available, all the interests of all those living in South Florida, together with all those not necessarily living in South Florida, who consider the Everglades ecosystem a national treasure, is more than just a scientific issue. Without some quantitative measures

of ecological conditions to trade-offs against quantitative measures of other water user interests, it becomes difficult to judge just what hydrology is ‘right.’ Clearly, it will depend in part on the money available to make it ‘right’ not only for restoring and preserving the Everglades but also for meeting the demands of the other water users in South Florida. Habitat suitability indices provide relative measures of these trade-offs with respect to the ecosystem. If water supply, flood control, and recreation are viewed as constraints, the essential trade-off is between cost and the relative overall measure of ecosystem habitat suitability.

An example of examining trade-offs was shown in our use of the habitat suitability indices to compare some water management alternatives and their impacts on various habitat indicators at different sites in the Everglades. Assuming our habitat suitability index functions for alligators are reasonable, we showed that the planned restoration flows with or without the planned ground water wells to be used for deep aquifer storage and recovery had no impact on alligator habitat in the Shark River Slough region. Removing the planned deep Lake Belt storage reservoirs, located along the East Coast, however, reduced the relative alligator habitat suitability in the same Shark River Slough region by about 20 percent. Elsewhere in the Everglades, the results could have been just the opposite. Habitat suitability indices provide a tool to examine where a particular restoration feature has the biggest benefit on a particular habitat or species, permitting better decision making on trade-offs over space with respect to that species. The decision process gets more complicated when more performance indicators are involved. Again, habitat suitability indices provide a way to examine potential trade-offs between impacts on different species and habitats, permitting informed decision making on alternative water management strategies.

To summarize, we have attempted to demonstrate a relatively quick, simple, and transparent way to consider the ecology of the Everglades prior to the accepted use of more complete ecosystem models. These include the Everglades Landscape Model (ELM) ([www.sfwmd.gov/org/wrp/elm/](http://www.sfwmd.gov/org/wrp/elm/)) and the Across Trophic Landscape System Simulation (ATLSS) models (<http://atlss.org/>). From our experience in this project, we have concluded that involving a large number of experts to define and combine habitat suitability index functions greatly enhanced communication amongst scientists with differing opinions and increased our combined understanding of everyone’s views, concerns, and knowledge as we were forced to come to consensus to define each habitat suitability index. Defining, documenting, and producing these habitat suitability indices, as part of the automated hydrologic modeling postprocessing, links hydrology to ecology and permits the quick and easy quantification of the ecologic benefits of alternative water management strategies. This is an important milestone in the process of linking water management and hydrology with ecologic restoration. This first step needs to be followed by further examination and refinement of the existing habitat suitability indices, the development of new indices, and, of course, continued research and development of more detailed ecological models. The production of these habitat suitability indices has enhanced inter-disciplinary and inter-agency communication and provided a tool that can be used to increase our ecological and hydrologic understanding to benefit Everglades’ restoration.





